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24203 7590 05/22/2008

GRIFFIN & SZIPL, PC
SUITE PH-1
2300 NINTH STREET, SOUTH
ARLINGTON, VA 22204

EXAMINER

LUU, CUONG V

ART UNIT

PAPER NUMBER

2128

DATE MAILED: 05/22/2008

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/540,861	06/27/2005	Kangbin Lei	ASAIN0165	4230

TITLE OF INVENTION: METHOD AND DEVICE FOR NUMERICAL ANALYSIS OF FLOW FIELD OF INCOMPRESSIBLE VISCOUS FLUID,
DIRECTLY USING V-CAD DATA

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1440	\$300	\$0	\$1740	08/22/2008

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. **PROSECUTION ON THE MERITS IS CLOSED.** THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN **THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE** OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. **THIS STATUTORY PERIOD CANNOT BE EXTENDED.** SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
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INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

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Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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TITLE OF INVENTION: METHOD AND DEVICE FOR NUMERICAL ANALYSIS OF FLOW FIELD OF INCOMPRESSIBLE VISCOUS FLUID, DIRECTLY USING V-CAD DATA

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nonprovisional	NO	\$1440	\$300	\$0	\$1740	08/22/2008

EXAMINER	ART UNIT	CLASS-SUBCLASS
LUU, CUONG V	2128	703-009000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a **Customer Number is required.**

2. For printing on the patent front page, list

- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
 (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☐ Issue Fee
☐ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

- ☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

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This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 342 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 342 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Notice of Allowability

Application No.

10/540,861

Examiner

CUONG V. LUU

Applicant(s)

LEI ET AL.

Art Unit

2128

- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 4/10/2008.
2. ☒ The allowed claim(s) is/are 1 and 4-15.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some* c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
- (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
- 1) ☐ hereto or 2) ☐ to Paper No./Mail Date ____.
- (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.
- Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08),
Paper No./Mail Date 1/16/08
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413),
Paper No./Mail Date ____.
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other ____.

DETAILED ACTION

Claims 1 and 4-15 are pending. Claims 2-3 have been canceled. Claims 1 and 4-15 have been examined. Claims 1 and 4-15 have been allowed.

Response to Amendment

1. The Applicant's amendment to the drawing filed 1/16/2008 have been considered and accepted.

Allowable Subject Matter

Claims 1 and 4-15 are allowed. The following is an examiner's statement of reasons for allowance:

2. As per claim 1, the prior arts of record teach a method for numerical analysis of a flow field of incompressible viscous fluid, directly using V-CAD data, comprising the steps of:
 - (A) dividing external data into a plurality of cells having boundaries orthogonal to each other, the external data including boundary data of an object which contacts incompressible viscous fluid;
 - (B) classifying the divided cells into an internal cell positioned inside or outside the object and a boundary cell including the boundary data;
 - (C) determining cut points in ridges of the boundary cell on the basis of the boundary data;
 - (D) determining a polygon connecting the cut points to be cell internal data for the boundary face;

(E) applying a cut cell finite volume method combined with a VOF method to a boundary of a flow field to analyze the flow field;

but do not teach the step (E) comprising following steps of:

i. applying a two-dimensional QUICK interpolation scheme to a convection term for space integral;

ii. applying central difference having precision of a degree of a second order to a diffusion term;

iii. combining the convection term and the diffusion term, and applying Adams-Bashforth method having precision of a degree of a second order to the combined convection term and diffusion term for time marching; and

iv. applying an Euler implicit method having precision of a degree of a first order to a pressure gradient term for time marching,

wherein for a two-dimensional boundary cell, a governing equation in the finite volume method is expressed by a governing equation (7),

$$\iint_{V_{i,j}} \frac{\partial \bar{u}}{\partial t} dV = - \iint_{V_{i,j}} \text{div}(\bar{u} \otimes \bar{u}) dV - \iint_{V_{i,j}} \text{div}(p\bar{I}) dV + \frac{1}{\text{Re}} \iint_{V_{i,j}} \text{div}(\text{grad}(\bar{u})) dV \quad (7)$$

$$- \iint_{V_{i,j}} \text{div}(\bar{u} \otimes \bar{u}) dV$$

wherein : corresponds to the convection term,

$$- \iint_{V_{i,j}} \text{div}(p\bar{I}) dV$$

corresponds to the pressure gradient term, and

$$+ \frac{1}{\text{Re}} \iiint_{V_{c,t}} \text{div}(\text{grad}(\vec{u})) dV$$

corresponds to the diffusion term, wherein \vec{u} designates velocity of flow of viscous fluid, V designates differential volume of the viscous fluid, $p\vec{I}$ designates pressure p of the viscous fluid along the \vec{I} vector, and Re corresponds to a non-dimensional Reynolds number; and

(F) outputting to an output device a result of the method for numerical analysis of the flow field of incompressible viscous fluid, wherein the output device prints, or displays, or prints and displays, the result;

As recited by the claimed invention.

3. As per claim 14, the prior arts of record teach a device for numerical analysis of a flow field of incompressible viscous fluid, directly using V-CAD data, the device comprising:

an input device for inputting external data including boundary data of an object that contacts incompressible viscous fluid;

an external storage device for storing substantial data of shape data and physical property data integrated into each other, and a storage operational program for the substantial data;

an internal storage device and central processing device for executing the storage operational program; and

an output device for outputting a result of the execution of the storage operational program;

wherein the device for numerical analysis

(A) dividing external data into a plurality of cells having boundaries orthogonal to each other, the external data including boundary data of an object which contacts incompressible viscous fluid;

(B) classifying the divided cells into an internal cell positioned inside or outside the object and a boundary cell including the boundary data;

(C) determining cut points in ridges of the boundary cell on the basis of the boundary data;

(D) determining a polygon connecting the cut points to be cell internal data for the boundary face.

(E) applying a cut cell finite volume method combined with a VOF method to a boundary of a flow field to analyze the flow field; wherein when the device for numerical analysis applies the cut cell finite volume method combined with a VOF method to the boundary of the flow field to analyze the flow field;

but do not teach the step (E) comprising following steps:

i. applying a two-dimensional QUICK interpolation scheme to a convection term for space integral;

ii. applying central difference having precision of a degree of a second order to a diffusion term;

iii. combining the convection term and the diffusion term, and applying Adams-Bashforth method having precision of a degree of a second order to the combined convection term and diffusion term for time marching; and

iv. applying an Euler implicit method having precision of a degree of a first order to a pressure gradient term for time marching,

wherein for a two-dimensional boundary cell, a governing equation in the finite volume method is expressed by a governing equation (7),

$$\iint_{V_{i,j}} \frac{\partial \vec{u}}{\partial t} dV = - \iint_{V_{i,j}} \text{div}(\vec{u} \otimes \vec{u}) dV - \iint_{V_{i,j}} \text{div}(p\vec{I}) dV + \frac{1}{\text{Re}} \iint_{V_{i,j}} \text{div}(\text{grad}(\vec{u})) dV \quad (7)$$

wherein $-\iint_{V_{i,j}} \text{div}(\vec{u} \otimes \vec{u}) dV$ corresponds to the convection term,

$-\iint_{V_{i,j}} \text{div}(p\vec{I}) dV$ corresponds to the pressure gradient term, and

$+\frac{1}{\text{Re}} \iint_{V_{i,j}} \text{div}(\text{grad}(\vec{u})) dV$ corresponds to the diffusion term, wherein \vec{u} designates velocity of

flow of viscous fluid, V designates differential volume of the viscous fluid, $p\vec{I}$ designates pressure p of the viscous fluid along the \vec{I} vector, and Re corresponds to a non-dimensional Reynolds number;

As recited by the claimed invention.

4. As per claim 15, the prior arts of record teach a computer readable medium comprising a program stored thereon for numerical analysis of a flow field of incompressible viscous fluid, directly using V-CAD data, wherein the program cause a computer to perform the steps of:
 - (A) dividing external data into a plurality of cells having boundaries orthogonal to each other, the external data including boundary data of an object which contacts incompressible viscous fluid;

(B) classifying the divided cells into an internal cell positioned inside or outside the object and a boundary cell including the boundary data;

(C) determining cut points in ridges of the boundary cell on the basis of the boundary data;

(D) determining a polygon connecting the cut points to be cell internal data for the boundary face.

(E) applying a cut cell finite volume method combined with a VOF method to a boundary of a flow field to analyze the flow field;

but do not teach the step (E) comprising following steps:

i. applying a two-dimensional QUICK interpolation scheme to a convection term for space integral;

ii. applying central difference having precision of a degree of a second order to a diffusion term;

iii. combining the convection term and the diffusion term, and applying Adams-Bashforth method having precision of a degree of a second order to the combined convection term and diffusion term for time marching; and

iv. applying an Euler implicit method having precision of a degree of a first order to a pressure gradient term for time marching,

wherein for a two-dimensional boundary cell, a governing equation in the finite volume method is expressed by a governing equation (7),

$$\iint_{V_{i,j}} \frac{\partial \vec{u}}{\partial t} dV = - \iint_{V_{i,j}} \text{div}(\vec{u} \otimes \vec{u}) dV - \iint_{V_{i,j}} \text{div}(p\vec{I}) dV + \frac{1}{\text{Re}} \iint_{V_{i,j}} \text{div}(\text{grad}(\vec{u})) dV \quad (7)$$

wherein $-\iint_{V_{i,j}} \text{div}(\vec{u} \otimes \vec{u}) dV$ corresponds to the convection term,

$-\iint_{V_{i,j}} \text{div}(p\vec{I}) dV$ corresponds to the pressure gradient term, and

$+\frac{1}{\text{Re}} \iint_{V_{i,j}} \text{div}(\text{grad}(\vec{u})) dV$ corresponds to the diffusion term, wherein \vec{u} designates velocity of

flow of viscous fluid, V designates differential volume of the viscous fluid, $p\vec{I}$ designates

pressure p of the viscous fluid along the \vec{I} vector, and Re corresponds to a non-dimensional Reynolds number; and

(F) outputting to an output device a result of the method for numerical analysis of the flow field of incompressible viscous fluid, wherein the output device prints, or displays, or prints and displays, the result;

As recited by the claimed invention.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Cuong V. Luu whose telephone number is 571-272-8572. The examiner can normally be reached on Monday-Friday 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamini Shah, can be reached on 571-272-2279. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. An inquiry of a general nature or relating to the status of this application should be directed to the TC2100 Group receptionist: 571-272-2100.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/Cuong V Luu/

Examiner, Art Unit 2128

/Hugh Jones/

Primary Examiner, Art Unit 2128